DOE PUBLIC WORKSHOP
SILO 3 PATH FORWARD
MAY 14, 1997

7:00 p.m.	Welcome/Opening Remarks	Gary Stegner
7:10 p.m.	Overview of Public Involvement and Decision-Making Process for Silo 3 Remediation	Terry Hagen
7:30 p.m.	Overview of Potential Technologies Available for Silo 3 Remediation	Don Paine
8:00 p.m.	Informal Question and Answer Session	
8:45 p.m.	Review of Action Items/ Closing Remarks	Gary Stegner
9:00 p.m.	Meeting Concludes	

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PUBLIC MEETINGS/AVAILABILITY SESSIONS FOR 1997 (some TBD)

FERNALD

January	February	March
7 CRO Meeting 11 Citizens Task Force 22 STCG 23 FRESH	4 CRO Meeting 12 IRT Availability Session 12, 13 Health Effects Subcommittee 26 IRT Public Briefing	4 CRO Meeting 13 CTF/FRESH & DOE/FDF 15 Citizens Task Force 18 STCG FRESH
April	**May**	**June**
1 CRO Meeting 3 FRESH 15 DOE Community Mtg. 22 DOE 10-Year Plan Mtg.	6 CRO Meeting 7 WM Subcommittee 7, 8 Health Effects Subcommittee 10 Task Force 14 Silos Project Workshop 20 Joint Response 21 CP&T Mtg. 21 EM Subcommittee 22 FRESH 27 OU2/OU5 Workshop	3 Silos Project Workshop - Nevada 3 CRO Meeting 10 STCG TBD Silos Project Workshop TBD Recycling Methodology Workshop
July	**August**	**September**
1 CRO Meeting 9 Citizens Task Force 24 FRESH TBD STCG TBD Silos Project Workshop	5 CRO Meeting TBD Public Involvement Workshop	2 CRO Meeting 20 Citizens Task Force 25 FRESH TBD STCG
October	**November**	**December**
7 CRO Meeting TBD DOE Community Mtg.	4 CRO Meeting 15 Citizens Task Force 20 FRESH TBD STCG	2 CRO Meeting

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SILO 3 PATH FORWARD - "STARTING POINT"

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- Task Force recommendations specific to Silo 3
  - Separate Silo 3 treatment from Silos 1 and 2
  - Evaluate appropriate treatment technologies

- DOE/Regulators concur to consider alternative treatment of Silo 3
  - Silo 3 Alternative Treatment Evaluation Report used to focus discussions - Not make decisions

- IRT recommendation specific to Silo 3

- Draft ACOE Value Engineering Study input

- Need to work Silo 3 path forward hand in hand with stakeholders
  - Treatment technology/performance criteria
  - Regulatory process to modify ROD (if required)
  - Stakeholders involvement in Silo 3 Request for Proposal

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SILO 3 TECHNOLOGY IDENTIFICATION

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- Propose to use a streamlined approach similar to feasibility study (FS) methodology

- Establish performance requirements

- Identify and screen universe of stabilization technologies
  - Screen using FS criteria of implementability, effectiveness, and cost
  - Preliminary expectation is a number of potential technologies will be screened out

- More detailed evaluation of technologies passing screening phase
  - Broad use of "nine criteria"

- Propose series of workshops to accomplish the above

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SILO 3 ROD MODIFICATION PROCESS

FERNALD

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- Propose modified Explanation of Significant Difference (ESD) Process

- ESD will:
  - Document technical basis for moving from vitrification
  - Document treatment technology/performance criteria identification

- Stakeholder involvement will include identified comment period for Draft Final ESD

- DOE will respond in writing to all comments prior to finalization of ESD

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PUBLIC INVOLVEMENT WITH SILO 3 RFP

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- Stakeholder involvement will include identified comment period for Draft RFP

- DOE will respond in writing to all comments prior to issuance of RFP

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SILO 3 SHORT TERM PATH FORWARD

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Approximate Time Line

Spring 1997	Summer 1997	Fall 1997

(Approximately 3 Months)
Public Consensus on Stabilization Technology/Performance Criteria

(Approximately 4 Months)
Final Draft ESD

30 Days
Public Review

30 Days
Response to Comments

△ Sign ESD

Develop Draft RFP
(Includes Public Interaction)

Public/Vendor Review of Draft RFP 30 Days

60-90 Days
Address Comments

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SILO 3 PATH FORWARD - "STARTING POINT"

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SILO 3 ROD MODIFICATION PROCESS

FERNALD

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- ESD will:
  - Document technical basis for moving from vitrification
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PUBLIC INVOLVEMENT WITH SILO 3 RFP

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SILO 3 SHORT TERM PATH FORWARD

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Silo 3

TREATMENT TECHNOLOGY EVALUATION

Public Workshop

May 14, 1997

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Silo 3 Waste
Physical, Chemical, and Radiological Characteristics

Physical	Chemical	Radiological
Pretreated by Calcination at 600°C to stabilize for storage	Metal Oxides	Thorium - 230
Powdery; Dry 5088 yd^3	High Sulfates and Phosphates High Aluminum, Calcium, Magnesium, Sodium and Iron	Alpha Emitter Airborne Inhalation Concern
Homogeneous	Inorganics TCLP Limit - Chromium 12 mg/L 5 mg/L - Selenium 12 mg/L 1 mg/L - Cadmium 6 mg/L 1 mg/L - Arsenic 42 mg/L 5 mg/L	Can be Contact Handled - No Shielding Required

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Silo 3
Waste Form Criteria

- Chemically bind hazardous characteristic constituents below Toxicity Characteristic Leach Procedure (TCLP) limits
- Physically bind in a solid waste form to eliminate airborne dispersibility of constituents of concern during handling, transport, and disposal
- Dry waste form to meet free liquids criteria for transport and disposal
- Maintain the radionuclide concentrations below the disposal site waste acceptance criteria limits

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Silo 3 Waste
Applicable Remediation Technologies

- "Feasibility Study Report for Operable Unit 4", 1994
- Literature from the "Encyclopedia of Technologies", 1992
- U.S. EPA "Stabilization/Solidification Processes for Mixed Waste", 1996
- Literature Survey of "Innovative Technologies for Hazardous Waste Site Remediation", 1987-1991
- U.S. EPA "Fifth Forum on Innovative Hazardous Waste Treatment Technologies: Domestic and International", 1994
- U.S. EPA "Remediation Technologies Screening Matrix and Reference Guide", 1993
- U.S. NRC "Workshop on Cement Stabilization of Low-Level Radioactive Waste", 1989

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EPA
Remediation Technologies, Screening Matrix
Soils, Sediments, Sludges

Physical/Chemical Processes	Thermal Processes	Other Processes
1. Solidification/Stabilization Full-Scale/Conventional	1. High Temperature Thermal Desorption Full-Scale/Innovative	1. Excavation and Off-Site Disposal Full-Scale/Conventional
2. Solvent Extraction Full-Scale/Innovative	2. Vitrification Full-Scale/Innovative	
3. Chemical Reduction/Oxidation Full-Scale/Innovative		

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Silo 3 Waste
Technologies Available

Technology	RI/FS	IRT
• Asphalt (Bitumen) Stabilization	X	X
• Cement Stabilization/Solidification	X	X
• Polymer (Micro) Encapsulation	X	X
• Vitrification	X	X
• Ceramics		X
• Ceramic Silicon Foam		X
• Macro Encapsulation		X
• Metal Matrix (Ceramet)		X
• Molten Metal Technology		X
• Thermal Setting (Epoxy) Resins		X
• Sulfur/Polymer Encapsulation		X
• Phoenix Ash Stabilization		

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Technology/Process Screening Factors

Effectiveness
- Mobility of constituents of concern
- Volume increase/decrease
- Waste Acceptance Criteria for characteristic metals
- Long-term effectiveness/permanence

Implementability
- Commercial availability
- Secondary waste produced
- Pretreatment required
- Processing throughput
- System reliability/maintainability

Cost
- Overall cost
- Capital or Operation, Maintenance, and Disposal Cost Intensive

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Asphalt (Bitumen) Stabilization

Process Description

Asphalt Stabilization is a process that physically binds the waste in a solid matrix. The process involves mixing solid waste in a liquid asphalt which, upon cooling, hardens into an elastic solid. This thermal process is encapsulation with no chemical binding of constituents of concern.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase.
- May not meet waste acceptance criteria for characteristic metals.
- Acceptable long-term effectiveness if disposed in an arid environment.

Implementability

- Mature technology; popular prior to land disposal requirements; rejected by power industry.
- Produces secondary waste - volitile gases.
- No pretreatment required.
- Large processing throughput achievable; flammability issue.
- More complex facility and equipment requirements than cement.
- Operator-friendly; easily maintained.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Cement Stabilization/Solidification

Process Description

The most widely used solidification/stabilization process for low-level mixed waste. Best demonstrated available technology for hazardous characteristic constituents. Chemically and physically binds costituents of concern. Waste is mixed with a variety of cement and chemical additive formulations. It is a nonthermal process requiring water as an activating agent for chemical binding.

Effectiveness

- Demonstrated ability to reduce mobility of Silo 3 hazardous constituents.
- Volume increase - 10% to 500%: treatability tests shows 20% increase in Silo 3 waste volume.
- Demonstrated ability to meet waste acceptance criteria for Silo 3 characteristic metals.
- Acceptable long-term effectiveness if disposed in arid environments (NTS and Envirocare).

Implementability

- Mature technology: numerous commercial vendors
- Produces secondary waste - HEPA filters.
- No pretreatment processes required.
- Large processing throughput achievable.
- Facility and equipment requirements are not complex.
- Operator-friendly; easily maintained.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Polymer (Micro) Encapsulation

Process Description

Polymer (Micro) Encapsulation is a thermal process which physically binds the waste in a thermoplastic polymer. Polyethylene is melted (100°C) and mixed with a dry waste using a commercially available extruder. The molten mixture is poured into the final disposal container where solidification occurs as the mixture cools.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase or decrease unknown.
- Requires development to ensure meeting waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Developmental technology; commercially available at Envirocare.
- Produces secondary waste - volitile gases.
- Pretreatment required; may require drying.
- Small-scale; large processing throughput achievable.
- More complex facility and equipment requirements than cement.
- Operator-friendly; easily maintained.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Sulfur/Polymer Encapsulation

Process Description

Sulfer Polymer Cement (SPC) is a process that produces a solid waste form where the constituents of concern are encapsulated in a cement, sulfur, polymer matrix. The sulfer provides a highly corrosion resistant cement while the polymer encapsulates the constituents of concern. SPC is a thermal process (135°C) requiring no chemical activation agents.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase.
- May require additives to chemically bind characteristic metals.
- Acceptable long-term effectiveness if disposed in arid environments (NTS).

Implementability

- Development technology; SEG has small-scale facility.
- Produces secondary waste - SO_2 and H_2S.
- Pretreatment required - moisture sensitive.
- Thermal process; computerized process control; flammability issues (Flash point 177°C).
- More complex facility and equipment requirements than cement; molten sulfur handling.
- Operator-unfriendly; maintainability more complex than cement.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Ceramics

Process Description

Ceramics is a process where the Silo 3 waste is mixed with dry ceramic formers and poured into a mold. The mold is then placed into an oven and heated, potentially under pressure, and then allowed to cool. Chemically bonded phosphate ceramics are used to produce a ceramic without oven heating. Producing magnesium phosphate creates an exothermic reaction that provides the heat required to form the ceramic.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase or decrease unknown.
- Development required to meet waste acceptance criteria for characteristic metals
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Developmental technology - INEL, Clemson University, Rocky Flats, Envirocare.
- Produces secondary waste - volitile gases.
- Pretreatment may be required; mechanical compression or drying.
- Processing throughput unknown.
- More complex facility and equipment requirements than cement; high temperature operations
- Operator reliability/maintainability unknown.

Cost

- Overall cost - medium.
- High capital cost.

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Metal Matrix (Ceramet)

Process Description

Metal Matrix (Ceramet) is a process where the Silo 3 waste is mixed with ceramic particles and metal (aluminum), pretreated with a proprietary treatment, melted, and then poured into a disposal container.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase or decrease unknown.
- Development required to meet waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Developmental technology, commercial availability unknown.
- Produces secondary waste - volitile gases.
- Pretreatment required - proprietary process.
- Processing throughput limited.
- More complex facility and equipment requirements than cement; high temperature operation.
- System reliability/maintainability unknown.

Cost

- Overall cost - high.
- High capital cost.

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Molten Metal Technology

Process Description

Molten Metal Technology involves the injection of the Silo 3 waste into a bath of molten metal, resulting in volume reduction through off-gasing of sulfates, carbonates, and phosphates, produces a metallic waste form and a secondary slag waste. This process has been used for volume reduction of nuclear reactor spent resins.

Effectiveness

- Reduces mobility of constituents of concern.
- Volume increase.
- Development required to meet waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Developmental technology.
- Produces secondary waste - SO_2, CO_x, PO_x.
- Pretreatment required - waste sizing requirement.
- Processing throughput limited.
- Facility and equipment requirements similar to vitrification.
- System reliability/maintainability similar to vitrification.

Cost

- Overall cost - high.
- High capital cost.

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Phoenix Ash Technology

Process Description

Phoenix Ash Technology involves the conversion of a mixture of fly ash, volcanic ash, or kiln dust and Silo 3 waste into a solid form, typically a brick. This stabilization process depends on high pH to stabilize characteristic metals.

Effectiveness

- Reduces mobility of constituents of concern.
- Potential volume decrease.
- Development required to meet waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Development technology - commercially available; one equipment vendor.
- Secondary waste produced - HEPA filters.
- Pretreatment required - mechanical compression; particle size-reduction and pretreatment for chromium and cadmium.
- Processing throughput limited.
- Facility and equipment requirements similar to cementation.
- System reliability/maintainability similar to cementation - except high pressures require more maintenance.

Cost

- Overall cost - medium.
- Capital and O&M cost similar to cementation.

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Thermal Setting (Epoxy) Resins

Process Description

Thermal Setting (Epoxy) Resins technologies are similar to polymer encapsulation processes. This is a thermal process which physically binds the waste in a polymer matrix.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase or decrease unknown.
- Requires development to ensure meeting waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability

- Developmental technology.
- Produces secondary waste - volitile gases.
- Pretreatment required; may require drying.
- Processing throughput unknown.
- More complex facility and equipment requirements than cement.
- System reliability/maintainability similar to polymer encapsulation.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Ceramic Silicon Foam

Process Description
Ceramic Silicon foam is an encapsulation process utilizing Dimethyl Silicon.

Effectiveness
- Reduces mobility of constituents of concern through physical binding.
- Volume increase - less volume increase than cementation.
- Requires development to ensure meeting waste acceptance criteria for characteristic metals.
- Would provide an acceptable long-term waste form for disposal.

Implementability
- Developmental technology.
- Produces secondary waste - volitile gases.
- Pretreatment required; may require drying.
- Processing throughput unknown.
- More complex facility and equipment requirements than cement.
- System reliability/maintainability similar to polymer encapsulation.

Cost
- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Macro Encapsulation

Process Description

Macro Encapsulation is a process typically used for discrete objects that cannot be size-reduced, which consists of placing the objects in a disposal container and pouring the encapsulation material over the object.

Effectiveness

- Reduces mobility of constituents of concern through physical binding.
- Volume increase.
- Would not meet waste acceptance criteria for characteristic metals.
- Would not provide an acceptable long-term waste form for disposal.

Implementability

- Mature technology; not applicable for Silo 3 waste.
- Produces no secondary waste.
- No pretreatment required.
- Large processing throughput achievable.
- Facility and equipment requirements are not complex.
- Operator-friendly; easily maintained.

Cost

- Overall cost - medium.
- Majority of cost associated with processing, packaging, shipping, and disposal.

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Proposed technologies to carry forward for detailed evaluation

- Cement Stabilization/Solidification
- Polymer (Micro) Encapsulation
- Sulfer/Polymer Encapsulation

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